Chapter 9

Indonesia's Real Steps Towards 2045

Riostantieka Mayandari Shoedarto

A. The Changes That Keep Rolling

Can you recall the last time you went a whole day without electricity? Without the soft glow of your laptop screen and the quiet hum of the gadgets that have become an extension of you? Let's take a trip down memory lane to the 18th century, when our energy scene was all about muscles and biomass ruling the roost. And then, bam! The Industrial Revolution hit in the mid-19th century, bringing coal to the party as the ultimate energy superstar. It powered steam engines and kept the world moving along. As the 20th century unfurled its chapters, coal maintained its dominance, but it was an era of subtle transition towards higher-energy-content sources, a journey that led us towards the beckoning horizon of oil. In the second half of the

R. M. Shoedarto
National Research and Innovation Agency, e-mail: rios003@brin.go.id

© 2023 Editors & Authors

Shoedarto, R. M. (2023). Indonesia's real steps towards 2045. In A. Kiswantono & R. M. Shoedarto (Eds.), *Indonesia's energy transition preparedness framework towards 2045* (307–323). BRIN Publishing. DOI: 10.55981/brin.892.c820, E-ISBN: 978-623-8372-41-6

1900s, petroleum became a big deal, stealing the show and creating a tangled mess of reliance in the global economy. It was an era of advanced technology that enabled us to produce nuclear electricity and find more gas. Back then, renewable sources like hydroelectric, wind, and solar energy were just starting to make their debut in the energy world. They were like quiet little whispers in the momentous symphony of energy.

In the 21st century, energy runs our lives like an unseen hand. It shines light on this text you are reading, facilitating the flow of information. Yet, it is not merely about lighting up rooms or charging devices, it is about thriving us in the whirlwind of the interconnected world, effortlessly engaging in social activities. Energy, harnessed through the combustion of fuels in engines, propels us forward, amplifying our capacities and supercharging human mobility. It is impossible to imagine a world without easy access to energy sources. The energy revolution keeps brewing for a sea change, until the advent of Covid-19 and the ongoing Russia-Ukraine War. While it is true that the pandemic and political turmoil have significantly hampered the growth of renewable energy and created an unclear trajectory for the energy transition overall, it became clear that our approach to energy must change to meet the needs of the present and ensure a sustainable future. As the world endured with the implications of the crisis, the journey of transition must go on.

This book is the real work of writers, researchers, and thinkers who accepted BRIN's invitation to be involved in collective thinking about the dynamics surrounding the energy transition that has been taking place in Indonesia since we resumed our daily lives after the pandemic. Within the pages of this book, you have found seven ideas that start the inception of the seven chapters in this book, covering the ins and outs of the multidimensional energy transition journey: from the depths of the ocean to the heights of urban landscapes; from preparation evaluations to appeals for equitable action; and from technical innovation to economic strategies and environmental management to navigating the uncharted waters of *Indonesia's Energy*

Transition Preparedness Framework Towards 2045. The seven chapters in this book are a legacy for future writers, potentially including you, to continue what has been written so as not to repeat from the beginning and avoid overlapping ideas.

B. Indonesia 's Ocean Energy Overlook

"*Nenek moyangku seorang pelaut …*"[1] is lyric from a song well-known to almost all of Indonesian children. Our seafaring ancestors were skilled mariners, finding immense joy in traversing the vast expanse of the world's oceans. The song from our early childhood is an ancestral hint that the ocean has enormous potential to be a source of energy in addition to having the ability to support marine life. Thus, Part 1 of the book, which also contains only one chapter, welcomes you into the vast blue space surrounding our world, the sea domain, with its unique possibilities. WIth all your dive gear, we dived in an exciting journey through the Indonesian islands, exploring the deepest parts where the promise of clean energy lies.

Although it is commonly recognized that the Earth's natural gas and oil reserves are located beneath the seafloor, the ocean itself has potential for energy production. The huge maritime region encircling the Indonesian archipelago plays an integral part in connecting the Asian and Australasian continents. Positioned within this unique web of water are the Sunda and Sahul tectonic plates, nestled amidst a predominantly shallow underwater landscape, with an average sea depth of 200 meters, or less (Ministry of Marine Affairs and Fisheries & USAID, 2018; Simanjuntak, 2006). A hidden universe appears throughout this expanse, complete with subaquatic passageways, deep sea basins, and hidden volcanoes. Notable among these geological features is the Banda region, boasting a profound underwater trench plunging to depths of 7,440 meters, while the Celebes Basin in Sulawesi claims the title of being the deepest at 6,220 meters (Asian Development Bank, 2014). Sill depths, where shallow areas border

[1] Roughly translated to "My ancestor was a sailor..."

deep depressions, are key ocean circulation channels. Geographical characteristics help cold water rise from the depths.

Indonesia, where the Pacific and Indian Oceans meet, has a diverse underwater terrain vital to global ocean circulation (Qu et al., 2005). The Indonesian Throughflow (ITF) is a central low-latitude corridor that transports warm, fresh Pacific Ocean water to the Indian Ocean. The upper cell's global overturning circulation, as highlighted by Feng et al. (2018), relies on this crucial component. The significant temperature contrast between warm surface water and cold deep-sea water holds the potential to serve as a renewable energy source known as Ocean Thermal Energy Conversion (OTEC), which is an emerging technology designed to generate electricity by harnessing this temperature difference.

Our journey begins with exploring OTEC into the theoretical potential of up to 30 terawatts on a global scale (Rajagopalan & Nihous, 2013). OTEC has tremendous potential in Indonesia, though its development is being prioritized over other renewable energy sources such as hydropower, solar cells, and geothermal energy. Writing about OTEC presents an opportunity for authors to explore techniques to increase OTEC knowledge and acceptance across various social segments and stakeholders, ensuring its high demand and redirecting developers' focus away from the financial barriers it currently implies. Despite its high development costs, OTEC has captured the interest of Indonesian renewable energy enthusiasts for years like Ristiyanto.

Together with his team, Ristiyanto investigated a range of offshore OTEC plant models, from resilient tension-based systems to robust tanker-based designs. They offer an insightful overview of Indonesia's oceanic energy landscape, where technological advancements intersect with system optimization. Here, we explore each of the three primary varieties of OTEC—closed cycle, open cycle, and hybrid cycle—functions as the central component of OTEC systems, facilitating thermal energy conversion into mechanical and electrical power. We also look into the inner workings of radial flow turbines

and the spine of the OTEC platform system, the unsung heroes of this green energy revolution.

Beyond the machinery, there is more to our dive into the ocean. We venture into the potential co-products of OTEC, shedding light on water desalination, hydrogen production, and the utilization of nutrient-rich, low-pollution deep-sea water for aquaculture, food production, cosmetics, and lithium extraction. By building connections with other local renewable energy sources, OTEC's ability to attract investment interest in Indonesia can be considerably increased. Collaboration with local economic and renewable energy opportunities in Indonesia also helps to explore the potential byproducts of OTEC further. However, our voyage also underscores the need to consider the possible environmental effects and ensure that our search for green energy does not adversely affect the health of our valuable ecosystem. The chapter has unequivocally demonstrated that OTEC is crucial to achieving Indonesia's goals for renewable energy, allowing the country to look forward to benefiting from OTEC's clean baseload electricity. Although the road ahead may be challenging, the promise of realizing commercial-scale OTEC power plants is within reach, offering a sustainable energy future while acknowledging the ocean's abundant resources as a divine blessing.

C. The Efforts for Successful Energy Transition

As previously told in Part 1, Indonesian ancestors fearlessly confronted the turbulent currents and were intimately familiar with the unpredictable storms that frequented the seas. Their experiences symbolize our journey to the unpredictable storm of changes and our approach to successfully navigate it. This inspires the conception of Part 2.

Energy transition involves more than just fuel mix changes or manufacturing technology changes. Social, economic, and technological systems must co-evolve to shape the shift (Cherp et al., 2018; WEF, 2021). Indonesia ranks 71st with a 2012–2021 Energy Transition Index (ETI) score of 56 out of 100 which is below the global average of 59.3. The total ETI score includes energy system

performance and transition preparedness subindices. As an emerging and rising Asian nation, Indonesia has a system Performance Index of 67.8 above the global's score; and Transition Readiness of 44.8, below the global average of 54.8 (World Economic Forum, 2021). Over the past decade, 70% of ETI-tracked countries have improved their energy system performance scores, indicating a growing capacity to deliver on economic development, energy access and security, and environmental sustainability.

Our journey arrives at a point where an important question arises that resonates and reverberates throughout institutions, governmental corridors, business sectors, and the public domain. To what extent is Indonesia prepared for the forthcoming decades? The inclusion of the article by Nugroho et al. is justified as it can provide a basis for future monitoring of the Energy Transition Readiness Index in the country. The authors embark on a comprehensive examination of Indonesia's readiness from multiple critical perspectives, encompassing the policy framework, charting our progress while identifying avenues for improvement. additionally, they explore the fertile ground of investment opportunities, realizing the potential to stimulate economic growth and create employment opportunities. In tandem, infrastructure development emerges as a pivotal puzzle piece, underscoring the necessity of robust foundations to integrate renewable energy sources into our infrastructure seamlessly. Ultimately, these insights lead to recommendations that outline our way to a more sustainable and secure energy future through dedication and strong collaborations.

The stakeholder analysis of collaborators in the renewable and sustainable energy sector in Indonesia often involves the utilization of the Political, Economic, Social, Technological, Legal, and Environmental (PESTLE) methodology, serving as a foundational tool for strategic decision-making (Yudha & Tjahjono, 2019). In Chapter Four, Majesty and Purnamasari's work focuses on breaking down the PESTLE framework into actionable strategies. They emphasize the necessity of ongoing interactions between governments, international standard-setting bodies, and the private sector. More frequent experi-

ence sharing and exhibiting of successful energy transition initiatives in Indonesia and other relevant countries is also crucial.

As a member of the Association of Southeast Asian Nations (ASEAN), Indonesia finds itself at a critical juncture due to the increasing domestic energy demand. This growth poses significant challenges in ensuring the provision of sustainable and cost-effective energy. Despite the renewable energy target established by the ASEAN to achieve 23.2% by 2025, the existing policies in several ASEAN countries only facilitate the implementation of renewable energy sources to a limited extent, accounting for less than 16.9% of the total. This indicates a significant gap of approximately 6.3% between the current progress and the desired target. In order to address this disparity, it is mandatory that each ASEAN nation, including Indonesia, assumes the responsibility of improving the proportion of renewable energy sources. The level of contribution is directly related to the country's size, the total energy demand within the country, and the presence of local renewable energy sources (ACE, 2023).

Majesty and Purnamasari also emphasize the importance of promoting electric vehicle stakeholders in the pursuit of decarbonization and a seamless energy transition. Additionally, they advocate for the establishment of a pool of energy transition specialists to safeguard against local and national brain drain. Their proposal encourages the collaboration of diverse sectors and media outlets to engage in public education campaigns, thus fostering capacity building and instigating behavioral change. Furthermore, the authors discuss innovative financial strategies aimed at expediting the diversification of funding sources for energy transition projects. Among the key stakeholders highlighted are the Coordinating Ministry for Maritime Affairs and Investment Affairs, the Chambers of Commerce, and the Ministry of National Development Planning, each holding significant importance and offering convenient accessibility. Nevertheless, the assessment underscores the importance of considering the relevance of other entities within this framework.

As the energy transition continues to evolve, stakeholder mapping must be refreshed to adapt to changing dynamics, make informed decisions, and enable a successful and inclusive energy transition to cleaner and more sustainable sources (Yudha & Tjahjono, 2019). Stakeholder mapping in energy transition involves identifying, categorizing, and analyzing the diverse entities and individuals with a stake in the transition from fossil-fuel-based energy systems to cleaner, more sustainable ones.

In this part, we are given the opportunity to gain an all-encompassing comprehension of the interests and motives of various stakeholders, evaluate their level of influence, and determine their relationships and interactions within the transition process. By categorizing stakeholders based on their influence and interest, this approach provides a nuanced understanding of who stands to gain or lose from the energy transition and helps decision-makers tailor engagement and communication strategies accordingly. As a fundamental tool, stakeholder mapping goes beyond identification to mitigate possible conflicts and build critical collaborations. It effectively amplifies voices, ensures accountability, and builds trust, proactively addressing issues and objections while advocating the transparency needed to negotiate the complex electricity industry. The power industry drives worldwide economic and social progress. Transitioning to renewable energy sources reduces carbon emissions, promoting environmental stewardship and sustainable progress.

The enhancements made by clean-energy businesses will play a significant role in mitigating the effects of global climate change. In this context, the chapter, "Clean Power for Indonesia: Leading the Way in the Energy Transition," underscores the efforts made by Indonesian clean energy companies. Hapsari discusses strategic ways to become a clean power company, emphasizing energy diversification with nuclear power, battery storage, carbon capture and storage (CCS), hydrogen, ammonia, and biomass. This strategic alignment between stakeholder mapping and clean energy developments ensures that Indonesia is well-prepared for a sustainable energy future and actively contributes

to mitigating the impacts of climate change through cleaner and more efficient energy solutions.

The author's primary focus is on developing the growth of renewable energy technologies and enhancing skills and knowledge in research, development, and implementation. Renewable technologies have environmental benefits and may provide jobs, economic possibilities, and sustainable energy availability for society. Also important is improving energy efficiency through regulations, including energy efficiency standards and incentive schemes. This unit is critical for decreasing energy use, operating costs, and greenhouse gas emissions. Infrastructure development, particularly sustainable transportation systems, electrified rail networks, and efficient mass transit networks, is also vital to the approach. This infrastructure is essential to minimize air pollution, greenhouse gas emissions, and fossil fuel use. Energy research and innovation require advancing energy technology, efficiency, and worker skills through collaboration worldwide.

Prioritizing sustainability and energy security is imperative to guarantee a reliable energy source while mitigating environmental impact. This overarching objective encompasses several key facets, including the advancement of renewable energy, the promotion of energy sustainability, and the strategic management of energy supply fluctuations. The integration of digital technologies, such as sensors, monitoring systems, data processing, and artificial intelligence, serves as a catalyst for enhancing energy management and monitoring capabilities. Through optimization, energy efficiency is improved, and the seamless integration of renewable energy sources is facilitated.

The localized and intermittent nature of renewable energy, coupled with its limited integration into the national power grid, presents a significant challenge. This chapter reminds us again that, being an archipelagic nation, Indonesia faces the predicament of a disparity between the geographical placement of its renewable energy sources and the centers of electricity demand. In response to this challenge, the State Power Company (PT Perusahaan Listrik Negara, PLN), has developed a comprehensive smart grid system, called the Green

Enabling Super Grid. This system includes various components such as the smart power plant, smart transmission, smart control center, smart distribution, and smart metering. The proposed implementation in Indonesia aims to establish interconnections among previously isolated electricity systems across various islands. Therefore, as per the author's viewpoint, the creation of inter-island transmission networks is crucial for expanding energy sources, decreasing environmental pollutants, and promoting economic growth and technological progress.

Hapsari recognizes that several Indonesian businesses have been developing and implementing clean energy technologies including solar panels, wind turbines, and other renewable energy systems, as well as promoting electric vehicles and employee carpooling, reducing air pollution and transportation's environmental impact. Waste reduction, recycling, and recycled materials are also priorities for certain companies. Public awareness campaigns concerning environmental challenges and sustainable business practices are growing. However, as the author reveals, clean power companies in Indonesia have their share of challenges. These challenges include the persistent barrier of limited access to cost-effective clean technology, a lingering dependence on fossil fuels, hurdles related to infrastructure development, and the ever-present ambiguity of environmental policies. Yet, amidst these formidable challenges lies an unparalleled opportunity for Indonesia's leaders to demonstrate their unwavering commitment to adopting clean and sustainable energy sources. The nation stands poised at a crossroads, with the potential to lead the way toward a more sustainable and progressive energy paradigm.

The concluding chapter within the comprehensive exploration of Part 2 "The Efforts for Successful Energy Transition" spotlights a particularly promising avenue: the advent of batteryless Roof-Top Solar Home Systems (SHS). This innovative approach holds the potential to revolutionize energy consumption while yielding substantial cost savings of up to 30% on electricity bills. Afianti propose the environmental promise that is equally compelling, focusing on reducing carbon emissions and nurturing a healthier environment.

Batteryless SHS, a beacon of sustainable energy, finds its applicability in areas already connected to the electricity grid. This versatile system can seamlessly function on-grid and off-grid by integrating with complementary energy sources like diesel generators.

The study further employed cutting-edge software to scrutinize the synergy of batteryless SHS and diesel generators against standalone diesel generators. The findings unveil a compelling advantage, showcasing that the combined operation of batteryless SHS and diesel generators could yield cost reductions of up to 43% compared to standalone diesel generators. This economic appeal is underscored by a conscientious examination of its environmental impact, revealing that SHS represents a far more environmentally benign choice than traditional diesel generators. However, the allure of significant cost savings—potentially reducing investment requirements by up to 35%—should not overshadow the essential caveat. It is paramount to recognize that the adoption of SHS may entail the production of waste materials. Therefore, it is critical to comprehensively understand these potential waste by-products and proactively address the associated challenges.

D. Environmental and Green Leadership

The last part, Part 3, highlights the fact that Indonesia's economy will continue to expand as energy demands increase. Indonesia possesses the potential to confront the energy trilemmas—energy affordability, security, and sustainability—within the context of energy challenges (World Energy Council, 2021). Nonetheless, this necessity has incurred environmental repercussions in the form of escalating pollution levels, deforestation, and the decline of biodiversity. Chapter 7, "Environmental and Green Leadership," highlights five fundamental facets of the Environmental Assessment (EA) for energy transition technology and green leadership in Indonesia. It is within this chapter that the crucial interplay between Indonesia's transition to renewable energy sources to address environmental challenges comes into focus. Khofsoh et al. assess the potential environmental implications

of the proposed energy transition technology in Indonesia, identify any negative environmental effects, and provide solutions to reduce those effects.

At the heart of this chapter lies the indispensable role of a comprehensive Environmental Assessment (EA) which comprehensively evaluates the potential environmental impacts of adopting energy transition technology in Indonesia. It assesses the effectiveness, feasibility, and costs of mitigation strategies to mitigate these effects while also considering the potential residual impacts on human health, cultural heritage, and economic dynamics. The EA also considers the potential for Indonesia to become a global leader in sustainable energy, with local communities benefiting economically and actively participating in cleaner energy resources.

In this complicated setting, the authors employ the Analytical Hierarchy Process (AHP) to aid in informed decision-making. This strategy combines expert insights with data analytics, allowing decision-makers to develop long-term energy investment policies specific to their communities. This knowledge enables them to make well-considered decisions on the best paths for switching to renewable energy sources while reducing negative environmental impacts. Furthermore, the EA process emphasizes the importance of public engagement and consultation. This ensures that all stakeholders, from communities to experts, have a platform to voice their concerns, provide input, and seek clarification on important matters. The EA process serves as a keystone, ensuring that Indonesia's transition to renewable energy sources unfolds sustainably and with a steadfast commitment to environmental responsibility.

Despite Indonesia's potential in various renewable energy sectors, challenges persist in attracting private power investment. Critical to overcoming these challenges is the unwavering support of the government. Such support is essential to mitigate uncertainties in project development and enhance the economic viability of renewable energy initiatives. The chapter also emphasizes the necessity of educating developers and lenders to foster an environment in which project

viability is safeguarded. International support in the form of finance, technology, human resources, and technical assistance remains indispensable for achieving these essential goals. Indicative of the nation's commitment to a greener and more environmentally responsible future, Indonesia has made remarkable advances in green leadership on its path to a more sustainable energy landscape.

With more capital and labor going into solar, wind, and hydropower projects, the country has made much progress in increasing its green energy capacity. These measures are vital for lowering Indonesia's reliance on fossil fuels and reducing greenhouse gas emissions. In addition, significant changes in policy, like feed-in tariffs and tax breaks made by the government, have made the private sector more interested in green energy projects. These policy changes show that Indonesia is serious about being a green star and being sustainable. At the local level, provinces and municipalities have also jumped on board with green energy options. They have started community-based renewable energy projects that show how sustainability can be done at the community level.

However, Indonesia has to deal with a number of problems and hurdles on its path to becoming a green leader. The fact that the country still relies on fossil energy, which accounts for 86% (IESR, 2022) is a big problem that needs to be solved in a way that protects both energy security and the environment. Infrastructure gaps, especially in rural and remote areas, make it harder for green technologies to be widely used because there are insufficient power connections and storage options. Also, getting investment for green energy projects is still problematic because the high start-up costs can turn off possible investors and developers. Indonesia's rules and regulations can take time to predict. For example, environmental laws and rules are sometimes changed, making long-term green project planning difficult. Lastly, getting more people to know about and understand the benefits of green energy still needs to be solved. For example, many Indonesians need to fully understand the benefits of using renewable energy or think it is hard to get. In order to advance the implementa-

tion of environmentally conscious leadership in Indonesia's energy transition, it is crucial to address and resolve these challenges.

According to WALHI (Wahana Lingkungan Hidup Indonesia-The Indonesian Forum for Living Environment) in 2014, companies are the primary cause of environmental devastation, accounting for 82.5% of all pollution in 2013 (Fahmi et al., 2020). Therefore, if efforts are not made to reduce environmental pollution, there will be a propensity for it to expand as the number of firms increases. Thus, the appropriate leadership style is required to solve this issue. Leaders need to know how to make their organizations more economically competitive, environmentally sustainable, and socially responsible. Businesses need to address today's environmental problems, hence, a company's leadership style will dictate how it reacts to its surroundings.

Harjadi, as the author of Chapter 8 trying to introduce the implementation of green leadership in Indonesia as agent of the transition at the sub-national level. Specifically, Harjadi pinpoints Central Java's energy transition that has yielded several commendable outcomes. The region has successfully developed various renewable energy projects, such as solar power and micro-hydro systems, which have become integral contributors to the local energy supply. Additionally, specific policies and programs promoting green energy adoption have positively impacted the environment and the well-being of the local population. However, despite these achievements, a series of challenges persist, including financial limitations, insufficient infrastructure, and a need for widespread public awareness regarding the benefits of renewable energy. Addressing these challenges necessitates a multidimensional approach involving the development of comprehensive and sustainable policies, improved coordination among stakeholders, heightened public education efforts, increased investment in infrastructure, and strategic partnerships with other regions to secure vital support.

These recommendations encompass several key actions. Firstly, it is advised to undertake in-depth research to identify the critical

factors influencing the successful implementation of green leadership in diverse regions across Indonesia. Additionally, comprehensive studies should be conducted to analyze the multifaceted impacts of the energy transition on the environment and society of Central Java. Furthermore, a comparative analysis is recommended, involving regions that have effectively implemented green energy policies and those encountering challenges. This comparative approach aims to identify differentiating factors contributing to success or obstacles. Another aspect involves investigating the effects of national policy changes on regional green energy policies. Lastly, specialized research is advised to delve into the role of local government in facilitating the development of renewable energy projects within Central Java. Each of these actions contributes to a comprehensive understanding and strategic approach to advancing green leadership in Indonesia's energy transition.

E. Prepare to embrace the shifting tides of life

In summary, Indonesia stands at a pivotal crossroads as it anticipates a demographic bonus in the coming decade. This juncture presents a dual narrative for the nation. On one front, Indonesia is blessed with abundant renewable energy potential, ranging from its vast coastlines and deep waters offering marine energy possibilities to the equatorial sun, a potent source for solar innovation. This wealth of resources promises to reduce pollution and positions Indonesia as a global leader in sustainable energy solutions. With Indonesia assuming the esteemed G20 2022 Presidency and the ASEAN chairmanship in 2023, a remarkable occasion arises to propel economic trajectories that effectively foster growth and climate objectives.

On the other front, the nation grapples with the ongoing challenge of fossil fuel dependence, exacerbated by economic considerations and infrastructural limitations. Undoubtedly, the transition to greener energy sources is likely to take time. We hope those chapters are more than just a collection of words; it is an invitation to a consecu-

tive opportunity for you to contribute to the narrative of Indonesia's ongoing energy transition.

As we conclude this voyage through the long and winding pathways of Indonesia's energy transition, we contemplate the profound wisdom of the timeless adage, "The only constant in life is change." It becomes clear that our ability to adapt is paramount. We cannot afford to lose momentum or, worse, go backwards. We must remain ever-prepared to embrace the shifting tides of life.

References

ASEAN center for Energy. (2023). *Measures and investment for clean energy dan power sector resilience in ASEAN* [Report]. https://aseanenergy.org/strategic-report-measure-and-investments-for-clean-energy-and-power-sector-resilience-in-asean/

Asian Development Bank (2014). *State of the coral triangle: Indonesia.* https://www.adb.org/ sites/default/files/publication/42409/state-coral-triangle-indonesia.pdf.

Cherp, A., Vinichenko, V., Jewell, J., Brutschin, E., & Sovacool, B. (2018). Integrating techno-economic, socio-technical and political perspectives on national energy transitions: A meta-theoretical framework. *Energy Research & Social Science*, *37*, 175–190. https://doi.org/10.1016/j.erss.2017.09.015

Fahmi, K., Kurniawan, T., Cahyono, Y., Sena, A., Suhadarliyah, Suryani, P., Sugianto A., Amelia, D., Musnaini, Amin, S., Hasbullah, H., Jihadi, M., Wijoyo, H., & Purwanto, A. (2020). Did servant, digital and green leadership influence market performance? Evidence from Indonesian pharmaceutical industry. *Systematic Reviews in Pharmacy*, *11*(9), 642–653. https://ssrn.com/abstract=3986858

Feng, M., Zhang, N., Liu, Q., & Wijffels, S. (2018). The Indonesian throughflow, its variability and centennial change. *Geoscience Letters*, *5*(1), 3. https://doi.org/10.1186/s40562-018-0102-2

IESR (2022). *Indonesia energy transition outlook 2023: Tracking progress of energy transition in Indonesia: Pursuing energy security in the time of transition*. Institute for Essential Services Reform (IESR). https://iesr.or.id/en/pustaka/indonesia-energy-transition-outlook-ieto-2023#unlock

Ministry of Marine Affairs and Fisheries, United States Agency for International Development (USAID). (2018). *State of the sea: Indonesia, volume one: An overview of marine resource management for small-scale fisheries and critical marine habitats in Indonesia*. https://pdf.usaid.gov/pdf_docs/PA00XBT2.pdf

Qu, T., Du, Y., Strachan, J., Meyers, G., & Slingo, J. (2015). Sea surface temperature and its variability in the Indonesian region. *Oceanography*, *18*(4), 50–61. https://doi.org/10.5670/oceanog.2005.05

Rajagopalan, K., & Nihous, G. C. (2013). Estimates of global ocean thermal energy conversion (OTEC) resources using an ocean general circulation model. *Renewable Energy*, *50*, 532–540. https://doi.org/https://doi.org/10.1016/j.renene.2012.07.014

Simanjuntak, T. (2006). Indonesia–Southeast Asia: Climates, settlements, and cultures in late pleistocene. *Comptes Rendus Palevol*, *5*(1–2), 371–379. https://doi.org/10.1016/j.crpv.2005.10.005

World Economic Forum. (2021). *Fostering effective energy transition 2021 edition.* [Insight Report]. https://www3.weforum.org/docs/ WEF_Fostering_Effective_Energy_Transition_2021.pdf

World Energy Council. (2021). W*orld energy trilemma index.* World Energy Council. https://www.worldenergy.org/assets/downloads/WE_Trilemma_Index_2021.pdf?v=1634811254

Yudha, S. W., & Tjahjono, B. (2019). Stakeholder mapping and analysis of the renewable energy industry in Indonesia. *Energies, 12*(4), 602. https://doi.org/10.3390/en12040602